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(54) Cruise control system

(57) In a vehicle cruise control system, a vehicle 20 is controlled at a set speed or operates to follow a safe distance behind a target vehicle 30 using a radar system 16A,26A. At low speeds or when the vehicle is halted, short range sensors 17B, 17C are used to detect if obstacles eg pedestrians 39 are present in a safety area substantially in front of the vehicle 20. If an obstacle 39 is detected in this safety area then the engine power is reduced and the brakes are applied if the vehicle is moving or the vehicle 20 is prevented from pulling away to follow the target vehicle 30 if it is already at rest.

A system whereby a series of emitters 31 inform the vehicle that it is approaching a red traffic signal 34 is also disclosed.

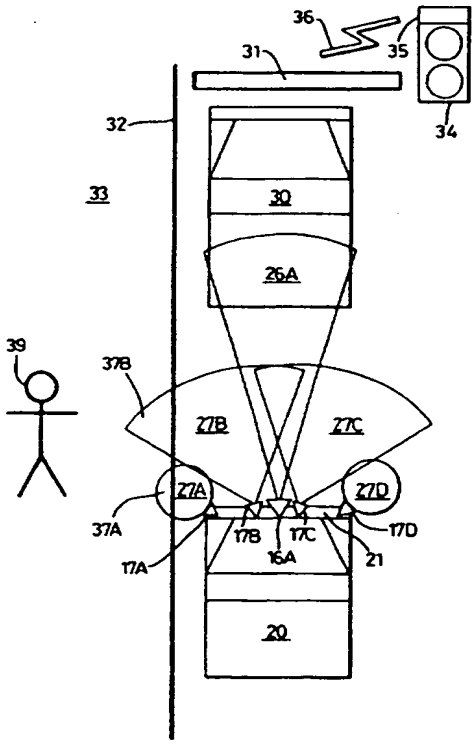

Fig. 3

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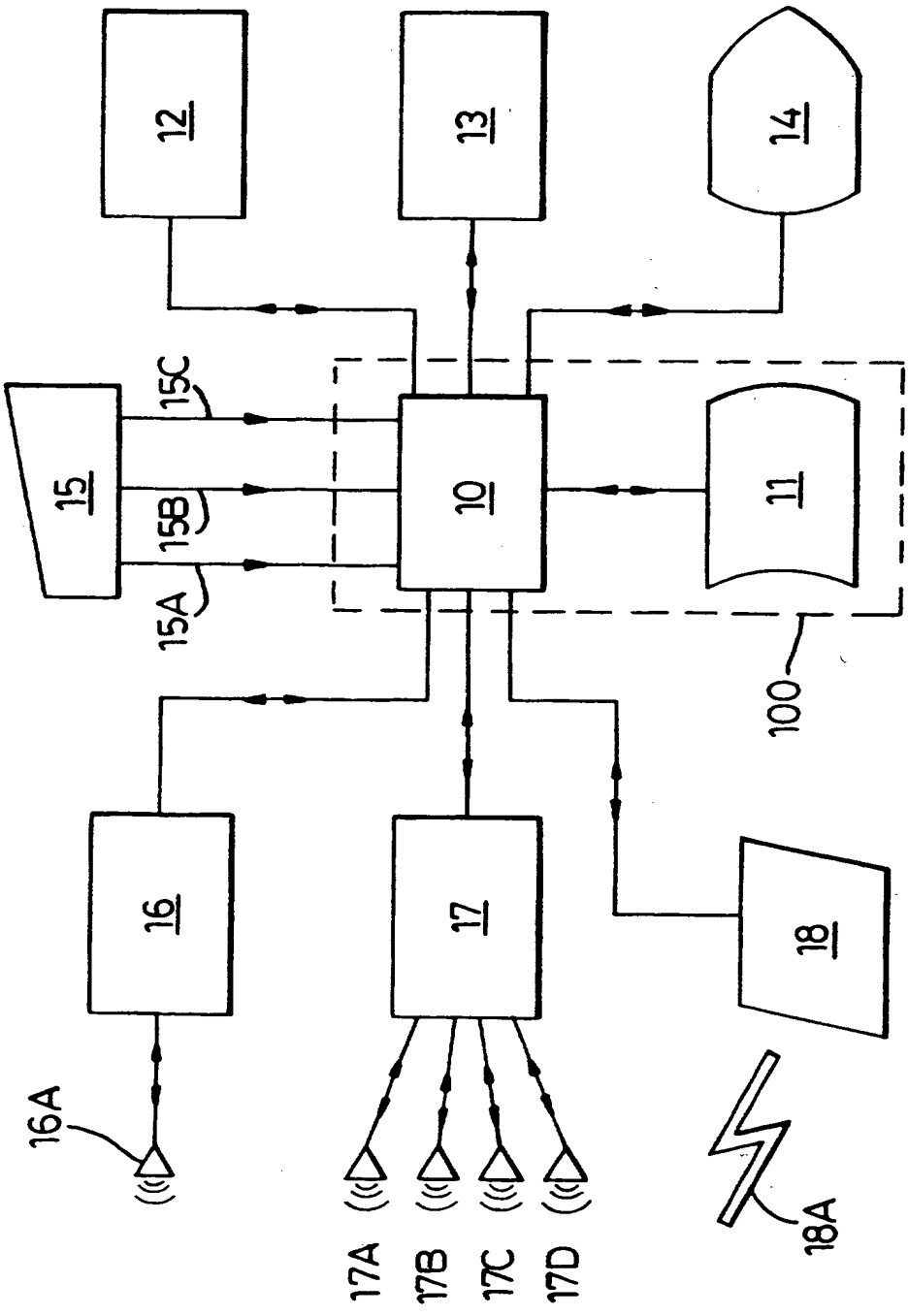


Fig. 1

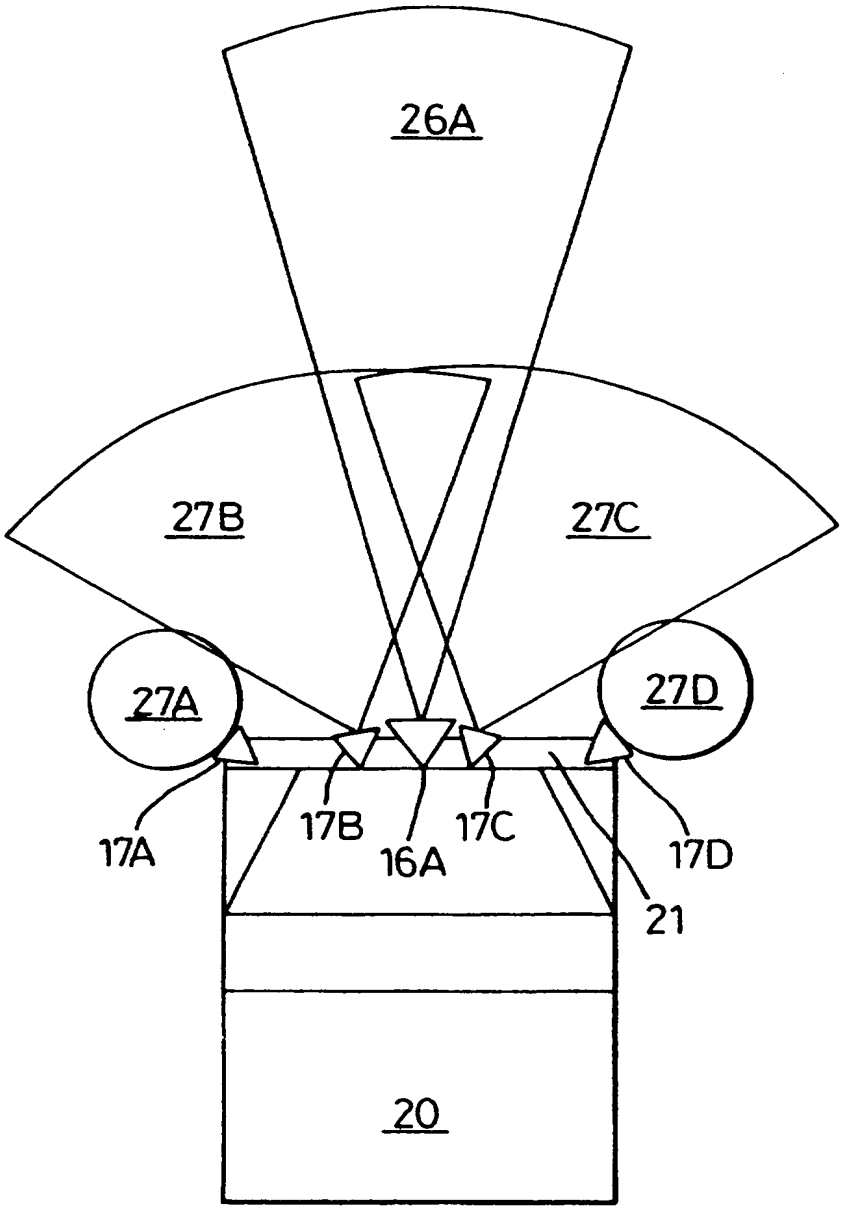
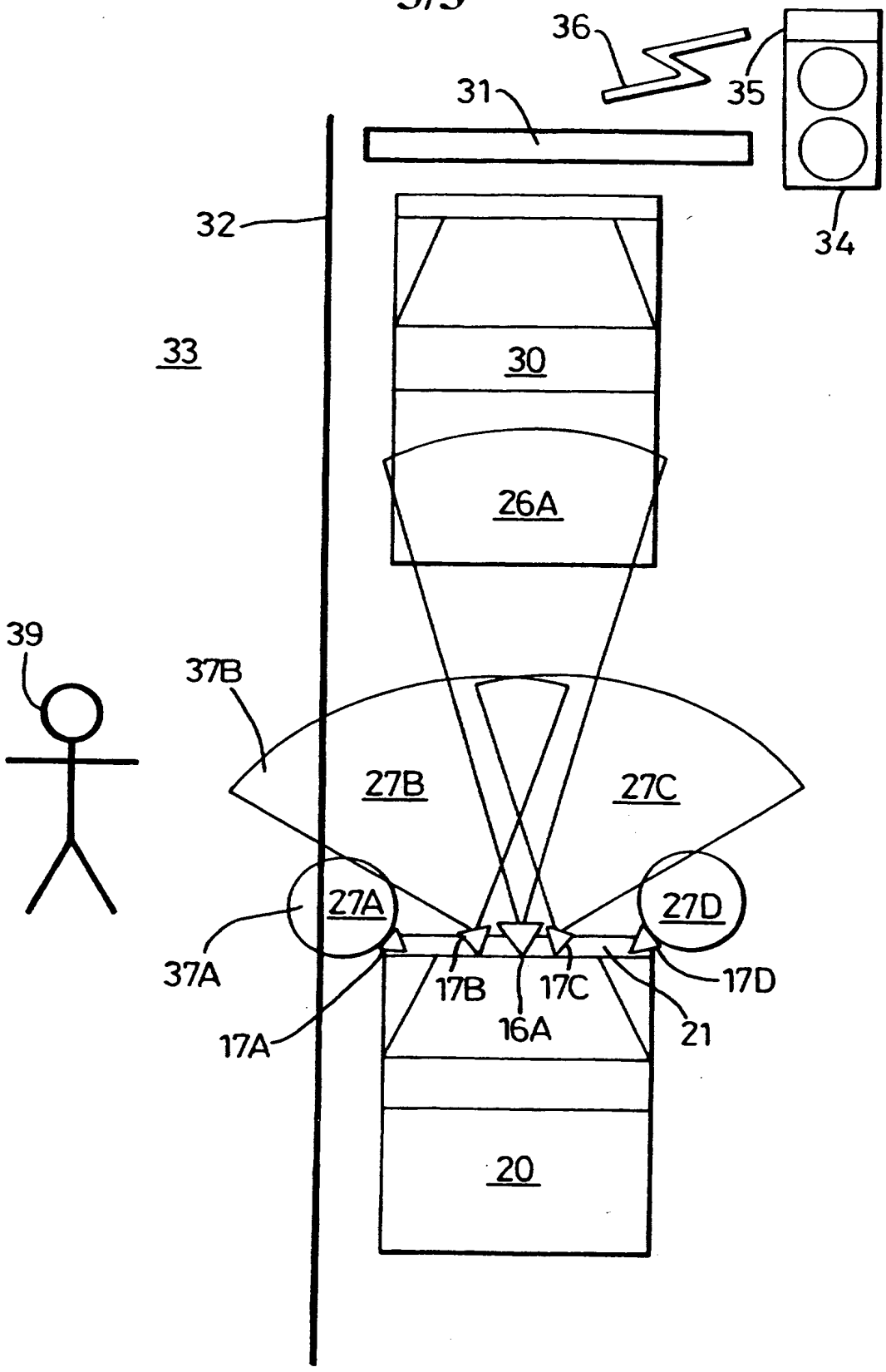


Fig. 2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17A
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Fig. 3

A Cruise Control System For A Motor Vehicle

This invention relates to cruise control systems for motor vehicles and in particular to a cruise control system which controls an acceleration of the vehicle from a halted state or from a low speed.

It is known to provide a motor vehicle with a cruise control system. Basic systems operate by providing an actuator which operates a fuelling member of the engine, such as a throttle butterfly. Such systems are limited in their deceleration ability by the engine braking available. The art has, to date, limited the lowest speed at which such systems can be engaged. For safety reasons, a typical lowest vehicle speed for cruise operation is 40 kph. If a system is engaged and the vehicle speed falls below 40 kph, the cruise control will disengage.

Recent proposals for cruise control systems include the control of acceleration and braking systems and employ sensors to detect vehicles travelling in the path of the equipped vehicle. Such an intelligent cruise control system is disclosed in EP0605104A1.

It is also known to provide a cruise control system which allows vehicles to travel safely at constant or varying velocities whilst maintaining a chosen spacing between them. These systems involve each vehicle monitoring the distance to the vehicle in front and forming up one behind the other, with variations in velocity being dictated by the lead vehicle. Such a convoy system is disclosed in EP0263262B1.

Though these systems operate adequately on open roads when the traffic is moving relatively freely, they still do not operate down to a fully halted condition or control an acceleration of the vehicle from rest. The

problem with automatic control of acceleration and braking at low speeds is the possibility of collision hazards not being detected, such as might happen if a pedestrian or pedal cyclist moved in front of the vehicle. Even the latest proposals for intelligent cruise control systems do not include a zero speed facility.

It is an object of this invention to provide a cruise control system which will control an acceleration of a vehicle from a halted state or from a low speed.

According to the invention there is provided a vehicle cruise control system comprising a sensor means operative to sense objects in a safety area substantially to the front of an equipped vehicle and a control means operative to control an acceleration means of said equipped vehicle in response to signals from said sensor means within a speed range of said equipped vehicle wherein said control means will accelerate said equipped vehicle from a halted state.

The invention also provides a cruise control system for a motor vehicle comprising a sensor means operative to sense objects in a safety area substantially to the front of an equipped vehicle and a control means operative to control an acceleration means of said equipped vehicle in response to signals from said sensor means within a speed range of said equipped vehicle wherein said control means will accelerate said equipped vehicle from a low speed. The low speed may be below 15 kph and may be of the order of 10 kph and the acceleration may be positive or negative.

The control means may be arranged to determine whether said objects form a collision hazard to said equipped vehicle and may be arranged to

determine whether a safe condition or an unsafe condition of said safety area exists dependent on the absence or presence of said collision hazards.

The control means may accelerate said equipped vehicle from a halted state only if it determines that a safe condition exists and may prevent an acceleration of said equipped vehicle if it determines that an unsafe condition exists.

The control means may be arranged to decelerate said equipped vehicle if it is moving and said control means determines that a collision hazard is present.

The acceleration means may be operated manually if said control means has determined that an unsafe condition exists.

The sensor means may be part of a parking aid system of said vehicle and the sensor means may comprise a short range sensor means and a long range sensor means.

The vehicle cruise control system may further comprise a deceleration means wherein said control means is operative to control said acceleration means and said deceleration means in response to signals from said sensor means within said speed range of the equipped vehicle between said halted state and a maximum controlled speed of said equipped vehicle.

The vehicle cruise control system may be arranged to accelerate said equipped vehicle from a halted state in response to a signal received by said cruise control system through a communicating means in communication with an external system not forming part of said equipped vehicle.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a cruise control system according to the present invention;

Figure 2 shows the sensor coverage of a vehicle equipped with the system of Figure 1; and

Figure 3 shows the equipped vehicle of Figure 2 in an urban road situation.

Referring to Figure 1, the cruise control system comprises a control means 100 which includes an electronic control unit (ECU) 10 in communication with a memory 11. The ECU 10 controls the speed of the equipped vehicle through an acceleration means in the form of a fuelling system 12 and a deceleration means in the form of an electronically actuated braking system (EBS) 13.

The driver gives instructions to the ECU 10 through manual input means 15 in the form of buttons representing set 15A, resume 15B and cancel 15C. When the driver wants to select cruise control on an open road, he presses the set button 15A for about 0.5S, known as a "short press". When the set button 15A is pressed, the ECU 10 stores the instant speed in the memory 11 and the driver then leaves the brake and accelerator pedals alone (neither shown).

The ECU 10 maintains the set speed by controlling the fuelling system 12 and the EBS 13. While under cruise control, the set button 15A has a second function which is to increase the set speed, known as "tap up". If the

set button 15A is depressed for a "short press", the ECU 10 will control the fuelling system 12 to supply more fuel and the equipped vehicle will be accelerated. Each "short press" of the set button 15A will "tap up" the set speed by 10 kph and the ECU 10 will hold the new higher speed and stores it in the memory 11.

If the brake pedal is depressed, the ECU 10 will interrupt the cruise function and vehicle operation will pass back to driver control of acceleration and braking. When the driver wishes to return to cruise control, he depresses the resume button 15B and the ECU 10 controls acceleration and braking until the latest set speed stored in the memory 11 has been reached, which speed will then be held. In similar fashion to the set button 15A, the resume button 15B also has dual functionality and is further used to lower the set speed, known as "nudge down".

When the driver wishes to lower the set speed in the memory 11, he depresses the resume button 15B for a "short press", whereupon the equipped vehicle slows down. The deceleration is achieved by reducing the fuel supplied by the fuelling system 12 to the engine (not shown) and letting engine braking supply the retardation.

Engine braking is used in preference to the EBS 13 for driver comfort but under certain conditions brake intervention from the EBS 13 may be necessary, such as during the descent of steep hills when engine braking alone may not be sufficient to overcome over-run in the gear selected.

The set speed is "nudged down" in 10 kph increments for each "short press" of the resume button 15B. The ECU 10 will hold the new lower speed, which also becomes the latest set speed in the memory 11. The

cancel button 15C is used when the driver wishes to cancel the selection of cruise control and the ECU 10 will clear the set speed from the memory 11.

The equipped vehicle 20 has a number of sensors 16A, 17A, 17B, 17C, 17D mounted on its front bumper which are arranged to detect the presence of objects ahead of the equipped vehicle 20.

If the equipped vehicle 20 approaches a preceding vehicle while already under cruise control, the equipped vehicle 20 will automatically adopt convoy control. If not under cruise control, the driver can choose to join the convoy and selects cruise control by a "short press" of the set button 15A. The cruise control system will then automatically adopt convoy control straight away.

Under convoy conditions, the ECU 10 raises and lowers the instant speed to match the chosen relative spacing up to a maximum of the most recent set speed stored in the memory 11. The set speed provides a datum speed from which the driver can "tap up" or "nudge down" with "short presses" of the set button 15A and the resume button 15B to achieve his desired maximum convoy speed. Under convoy conditions there is no need for the driver to manually alter the vehicle speed, as the cruise control will maintain the chosen gap to the preceding vehicle.

If the convoy accelerates away beyond the maximum set speed, the cruise control holds its maximum set speed and becomes independent of the convoy, unless the driver increases the maximum set speed by "tapping up". If the convoy is caught up later, the equipped vehicle 20 will rejoin it automatically if still in cruise control.

Referring also to Figure 2, one of the sensors comprises a long range sensor means in the form of a Doppler shift radar 16 with an associated radar antenna 16A. The radar antenna 16A is mounted in the centre of a front bumper 21 of the equipped vehicle 20. The radar 16 is used to detect a preceding target vehicle (not shown in Figure 2) travelling in the same path as the equipped vehicle 20. The radar 16 projects a narrow radar beam 26A of 10° width forwards and determines the direction, speed and ranging of a distant object (such as a target vehicle).

The radar 16 operates in accordance with techniques known in the art and measures the projected angle and time intervals between the transmission of electromagnetic waves and the reception of their subsequent reflections off an illuminated distant object. Such a long range sensor means is discussed in EP0605104A1 and is used by the ECU 10 to maintain a chosen travelling distance in conjunction with other inputs such as a road speed signal (not shown) of the equipped vehicle 20.

The equipped vehicle 20 further comprises a short range sensor means in the form of a parking aid system 17 which includes four ultrasonic sensors 17A, 17B, 17C, 17D and provides good resolution of objects at ranges up to about 2 metres. The parking aid system 17 uses the information from the sensors 17A, 17B, 17C, 17D to provide an audio visual display to the driver of the likelihood of collision with an object which may be hidden from his view when manoeuvring to park the vehicle.

Systems of the type which are used in this invention as a parking aid system 17 are known and are discussed, for example, in GB2284028A and DE4333112A1. In this invention the parking aid system 17 also makes

short range information obtained by the sensors 17A, 17B, 17C, 17D available to the cruise control ECU 10 for use in cruise control operation.

Sensor 17A is positioned near the near-side front corner on front bumper 21 and sensor 17D is positioned near the off-side corner. Sensors 17B and 17C are positioned on front bumper 21 either side of the centrally mounted radar antenna 16A.

Sensors 17A, 17B, 17C, 17D provide short range ultrasonic detection of close objects (none shown in Figure 2) within their respective fields 27A, 27B, 27C and 27D and the ultrasonic system 17 provides signals to the ECU 10 of such close objects.

Sensors 17A, 17B, 17C, 17D are arranged so that there is an overlap between their fields. Field 27A overlaps field 27B, which also overlaps field 27C, while field 27C further overlaps field 27D.

The ultrasonic system 17 and the radar 16 use different frequency signals to achieve their different ranges and consequently any interference between radar beam 26A and fields 27B and 27C is easy to eliminate using band stop filtering. To eliminate mutual interference between adjacent ultrasonic sensors, their respective emission of signals is timed such that potentially interfering signals do not reach an adjacent sensor during the feasible time frame of its own reflections. By manipulation of the overlap and timing settings of the ultrasonic sensors, it is made impossible for a pedestrian (not shown in Figure 2) to move in front of the equipped vehicle 20 without being detected.

There are known problems with the operation of radar at close ranges. In this case, for example, at 2m the reflections from the radar beam 26A may saturate the input circuits of the radar 16 and the useful detection ability of the system would then be seriously impaired. Further problems occur if the radar cannot properly lock on to the target vehicle, such as when it is a high bodied lorry and the relatively low positioning of the radar antenna 16A means that the radar beam 26A is projected below what might be a substantial overhang. In circumstances such as these, the ultrasonic system 17 is used to augment, complement, back up and if necessary over-ride the radar 16 for close-in warnings.

Referring also to Figure 3, an urban road situation is shown. The equipped vehicle 20 of Figure 2 is shown close to a curb 32 which defines a pavement 33 and the reference numerals of Figure 2 are used to describe features common with that drawing.

The radar beam 26A is shown to have illuminated a preceding target vehicle 30 and the reflections therefrom are converted by the radar 16 into signals used by the ECU 10 to maintain a chosen distance between the equipped vehicle 20 and the target vehicle 30 as described above with respect to convoy control.

The target vehicle 30 is shown to have halted at a stop line 31 under driver control in response to a red light on the traffic light 34. The equipped vehicle 20 has been brought to a halt behind the target vehicle 30 by the fuelling system 12 and the EBS 13 under the control of the ECU 10 in response to a signal from the radar 16.

Due to the narrow width of the radar beam 26A, the radar 16 will not detect objects approaching from the side until they are right in front of the equipped vehicle 20.

The ultrasonic system 17 continuously scans a safety area around the equipped vehicle 20, which safety area is defined by the coverage of fields 27A, 27B, 27C, and 27D. The signals from the ultrasonic system 17 are formed into a collision hazard map (not shown) by the ECU 10 and stored in the memory 11. The map shows the relative position and movement of close objects and is continuously updated in real time.

There are sections of fields 27A and 27B which overlap the curb 32 and the pavement 33 by varying degrees, numbered as areas 37A and 37B respectively. The ECU 10 uses areas 37A and 37B to provide early warning of a close object, such as a pedestrian 39, moving towards the safety area. The pedestrian 39 is detected on entering area 37A or 37B and his relative progress can be monitored and subsequent movements interpolated thereby.

If the pedestrian 39 is moving in a direction which by dead reckoning will not bring him into danger within the safety area, his movements are monitored and mapped but no other action is taken. If there are no collision hazards, the ECU 10 will determine that the safety area is in a safe condition.

When the traffic light 34 changes to green and the target vehicle 30 pulls away, the ECU 10 will instruct the fuelling system 12 to supply more fuel and the equipped vehicle 20 will pull away and follow the target vehicle 30 under convoy control as described above.

If dead reckoning interpolation of the movements of the pedestrian 39 places him in the safety area, or he does in fact enter it further in a potentially hazardous direction, the ECU 10 will determine that the safety area is in an unsafe condition. When the target vehicle 30 pulls away, the ECU 10 will limit the fuelling system 12 to idle speed control, thus preventing acceleration and will use the EBS 13 to apply the brakes (not shown) and the equipped vehicle 20 will not move until the collision hazard has disappeared.

When both long and short range sensing means detect a clear path ahead, the ECU 10 will remove the braking force applied by the EBS 13 and accelerate the equipped vehicle 20 using its fuelling system 12.

If a close object has caused a collision hazard such that there is a large gap between the vehicles, it is possible for a further collision hazard to form in that large gap which is beyond the range of the sensors 17A, 17B, 17C, 17D and also not caught in the radar beam 26A. While the equipped vehicle 20 is accelerating to its set speed, it might not be possible for the ultrasonic system 17 to provide enough warning of a pedestrian 39 in such a position in time to reduce fuelling and apply the EBS 13. To overcome this danger, if the ECU 10 has over-ridden the acceleration signal, the driver has the responsibility to check that it is clear to progress. To prevent a dangerous acceleration in those situations, the resume button 15B cannot be used to cause an acceleration if the equipped vehicle 20 has been brought to a halt as a result of signals from the ultrasonic system 17. The driver must then accelerate the equipped vehicle 20 by positively depressing the accelerator pedal (not shown).

When the equipped vehicle 20 is moving above 10 kph, the resume button 15B can be pressed and the ECU 10 will accelerate the equipped vehicle 20 up to its latest set speed from the memory 11, or rejoin the convoy if it catches that up first.

In similar fashion, the ECU 10 will accelerate or decelerate the equipped vehicle 20 if it detects a collision hazard while moving slowly. Such a collision hazard may also comprise a vehicle, such as a cyclist, over-taking the equipped vehicle 20 in slow moving traffic. If the equipped vehicle 20 is moving at a low speed (e.g. below 15 kph) and the ECU 10 has adopted cruise control to follow a preceding vehicle but a potential collision hazard such as an over-taking cyclist is detected, the ECU 10 will determine the likelihood of a collision with this hazard. If there is a likelihood of collision, the ECU 10 will not accelerate the equipped vehicle 20 to keep up with the preceding vehicle and will also decelerate the equipped vehicle 20 if necessary to avoid a collision, which will abandon convoy control and may even bring the equipped vehicle to a halt. The deceleration may take the form of engine braking or in more severe cases may require the application of the EBS 13.

The detection of a collision hazard will in all cases over-ride all commands to accelerate the equipped vehicle 20 and it will be decelerated, unless the driver uses the cancel button 15C to deselect cruise control or alternatively he can accelerate the equipped vehicle 20 manually.

The cruise control system disclosed herein further comprises a communicating means in the form of a radio transceiver 18 operative to establish a communications link 18A with systems not forming part of the equipped vehicle 20. This feature allows the ECU 10 to receive a radio

signal 36 from a radio transceiver 35 integrated with the traffic light 34, thereby allowing for communications to be established along a link 18A for the radio signal 36. When the equipped vehicle 20 approaches the traffic light 34, the ECU 10 can receive the radio signal 36 from the transceiver 35 indicative of the state of the traffic light 34. If the traffic light 34 shows a red light, the ultrasonic system 17 is then used to detect the position of the stop line 31 by detecting signals from transponders (not shown) included below the road surface at the stop line 31. When the traffic light 34 is on red, these transponders broadcast signals (not shown) simulating collision hazards which signals are detected in fields 27A to 27D along the stop line 31. The ECU 10 will halt the equipped vehicle 20 at the stop line 31. This feature allows the ECU 10 to safely control the speed under cruise conditions even if there is no preceding target vehicle 30. When the traffic light 34 changes to green, the signals from the transponders under the stop line 31 are switched off and it is the driver's responsibility to provide a resume signal by depressing the resume button 15B in the conventional manner for cruise control systems as discussed above. If a collision hazard has been detected and not cleared by the time the traffic light 34 changes to green, however, the fuelling system 12 remains in idle speed control and the EBS 13 maintains braking force. The driver then has three options: to use the cancel button 15C, to accelerate the equipped vehicle 20 manually, or to wait for the hazard to clear itself and let the ECU 10 retain control. Once the collision hazard has cleared, the resume button 15B can be used normally.

A display means is provided in the form of an instrument panel 14 which shows the state of the cruise control selection, the set speed and includes a warning light to indicate if there is a close object collision hazard.

This warning light is further used to indicate that the cruise control system will not accelerate the equipped vehicle 20 and that the driver must press the cancel button 15C, accelerate the equipped vehicle 20 manually or wait until the ECU 10 determines that the safety area is clear.

The long and short range sensing means may be in forms other than those disclosed above, such as transceivers of light energy. The short range sensing means could, as in the embodiment of the present invention discussed above, form part of a parking aid system and signals could be supplied to the control means therefrom, thus saving the expense and complexity of a dedicated short range sensor array. The operating characteristics of any such parking aid system may be altered under the authority of the ECU 10 to meet the cruise control requirements when the cruise control system has been engaged. The communicating means could also be used to provide a diagnostic and tuning capability for the cruise control system. Transceiver 35 may pass further information to the communicating means 18 indicative of local hazards, such as might be available to it through sensors of its own which could cover an area outside the range or coverage of the ultrasonic system 17 or the radar 16.

CLAIMS

1. A cruise control system for a motor vehicle comprising a sensor means operative to sense objects in a safety area substantially to the front of an equipped vehicle and a control means operative to control an acceleration means of said equipped vehicle in response to signals from said sensor means within a speed range of said equipped vehicle wherein said control means will accelerate said equipped vehicle from a halted state.

2. A cruise control system for a motor vehicle comprising a sensor means operative to sense objects in a safety area substantially to the front of an equipped vehicle and a control means operative to control an acceleration means of said equipped vehicle in response to signals from said sensor means within a speed range of said equipped vehicle wherein said control means will accelerate said equipped vehicle from a low speed.

3. A cruise control system according to Claim 1 or Claim 2 wherein said control means is arranged to determine whether said objects form a collision hazard to said equipped vehicle.

4. A cruise control system according to Claim 3 wherein said control means is arranged to determine whether a safe condition or an unsafe condition of said safety area exists dependent on the absence or presence of said collision hazards.

5. A cruise control system according to Claim 4 wherein said control means will accelerate said equipped vehicle only if it determines that a safe condition exists.

6. A cruise control system according to Claim 4 or Claim 5 wherein said control means will prevent an acceleration of said equipped vehicle if it determines that an unsafe condition exists.

7. A cruise control system according to any one of Claims 3 to 6 wherein said control means is arranged to decelerate said equipped vehicle if it is moving and said control means determines that a collision hazard is present.

8. A cruise control system according to Claim 5 or Claim 6 wherein said acceleration means may be operated manually if said control means has determined that an unsafe condition exists.

9. A cruise control system according to any preceding Claim wherein said sensor means is part of a parking aid system of said vehicle.

10. A cruise control system according to any preceding Claim wherein said sensor means comprises a short range sensor means and a long range sensor means.

11. A cruise control system according to any preceding claim arranged to accelerate said equipped vehicle in response to a signal received by said cruise control system through a communicating means in communication with an external system not forming part of said equipped vehicle.

12 A cruise control system substantially as described herein with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9701467.4
Claims searched: 1 & 3-12

Examiner: Mr Andrew Bartlett
Date of search: 18 March 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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F2F (FC)

Int Cl (Ed.6): B60K 28/00,31/00; B60R 21/34; B60T 7/12,7/18; G01S 13/88,13/93, 17/88,17/93; G05D 1/00,1/02,1/03; G08G 1/16;

Other: ONLINE:- WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage			Relevant to claims
A	GB 2295695 A	(Lucas Industries)	See whole document	1 at least
A	EP 0605104 A1	(Jaguar Cars)	See whole document	1 at least
A	US 4779095	(Guerreri)	See col 2 line 52-55 in particular	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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